P. Ravenscroft[1] R.J. Howarth[2] and JM. McArthur[2] 2006. Comment on "Limited Temporal Variability of Arsenic Concentrations in 20 Wells Monitored for 3 Years in Araihazar, Bangladesh" 2006. Environ. Sci. Technol., 40, 1716–1717.

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On the basis of 3 years of monitoring arsenic concentrations in 20 wells in a small area of Bangladesh, Cheng *et al.* (1) show that arsenic concentrations change very little in most wells and in all wells deeper than 10 m and draw conclusions from those trends. This comment accepts their data but widens the scope to discuss data and conclusions that are contrary to their view. Cheng *et al.* (1) state that their "most important conclusion.... is that groundwater As concentrations typically do not vary over time." This conclusion is drawn in isolation from other available information and is potentially unsafe if extrapolated beyond their 20 wells or into the future.

Three years of monitoring, while admirable and valuable, is too short a time for solid conclusions to be drawn. Without qualification, the implication to be drawn from their work by tube well owners, or their advisers, is that the arsenic concentration of well water will not change over time and, most importantly, that wells tested "safe" (*i.e.* below 10 or 50 μg/L) will remain safe. By omitting discussion of well documented analyses that run counter to their conclusions, they risk exposing unsuspecting consumers of tube well water to dangerous concentrations of arsenic.

The cause of arsenic pollution in the Bengal Basin is reductive dissolution of iron oxyhydroxides (2–5), a process that is neither "elusive" nor "poorly understood" as Cheng *et al.* contend. This mechanism provides a basis for understanding why arsenic concentrations might increase over time, remain constant for a period, or even decrease with time (5, 6) as the sedimentary stores of As, Fe, or dissolved organic carbon become limiting. Although uncertainties about the rates of groundwater flow, the source and migration of organics, and sorption of arsenic make quantitative prediction of trends difficult, in the long run dissolved As concentrations will decrease everywhere as the flushing of aquifers proceeds (5). Fromthe perspective of human health, the most important scenario is the possibility that arsenic concentrations might increase in the short-to-medium term, and here we focus exclusively on that trend.

Six sources that are either not cited or not discussed by Cheng *et al.* present evidence for increasing arsenic concentrations over time. Firstly, the Department of Public Health Engineering of Bangladesh (6) presented data from high-capacity municipal production wells monitored by the 18 District Towns Project in Bangladesh (7, 8) that showed that concentrations of arsenic in some wells increased over a period of about 2 years, while they decreased in other wells. Secondly, Chakraborti and his coworkers (9) have reported repeat analyses of tube wells that show increasing arsenic concentrations between samplings. Although doubts have been expressed, in informal media, about the equivalency of sampling and analytical protocols, it is improbable that all are in error, and hence it is likely that many increases are real. Thirdly, a village-level study of 70 wells near Meherpur in Western Bangladesh (10) and, fourthly, data from over 2000 wells in 250 of the most arsenic-affected upazilas (5, 6, 11, 12) strongly suggest a trend of increasing arsenic concentration over time. Analyzed by year of installation, the data show that approximately 25% of newly completed wells (<2 years old) exceeded 50 μg/L, increasing to 40–50 % in wells 8–12 years old. These studies inferred statistically significant relationships that show the proportion of wells exceeding various threshold concentrations between 50 and 200 μg/L increased with age for periods up to approximately 10 years. The feasibility of water-well concentrations increasing from an initially heterogeneous distribution of arsenic is supported by modeling studies (13). Fifthly, similar inferences have subsequently been reached by others. Evaluation of 6000 water-well analyses in Araihazar (14) showed that As concentrations increase over a period of years to decades and derived a pooled estimate for the rate of increase of 16 (2 μg/L per decade. Finally, examination of more than 300 000 field test analyses in 15 of the most severely arsenic-affected upazilas (15) indicated greater pollution in older wells. Dividing the data set into 5-year age classes indicated no change in the proportion of wells exceeding 50 μg/L in the 0–5, 6–10, and 11-15 year groups (64 ± 1%) but higher proportions in the 16–20 (68%), 21–25 (72%), and >25 (75%) year groups. No other differences between the younger and the older wells were identified.

Combining the statistical-historical and geochemical lines of evidence strongly advocates caution in interpreting the small data set of Cheng *et al*. Further reason for caution arises from the fact that, since about 1998, an increasing awareness of arsenic pollution in the Bengal Basin has led some (perhaps many) existing and prospective well owners to modify well use by abandoning, switching, or deepening tube wells (e.g., ref 16 and personal observations of many others). The data presented by Cheng *et al*. are encouraging but cannot invalidate the statistical inferences reported above. In the medium term, the trends of arsenic concentration are uncertain. The Precautionary Principle demands that the inferred increases highlighted here are accepted as possibly correct and therefore that "safe wells" are monitored at intervals of not more than a few years (as Cheng *et al.* advocate). We concur with their call for continued monitoring, the only responsible action is to routinely monitor arsenic concentrations in partially impacted areas. However, when hard-pressed fieldworkers, whether in the government, private, or voluntary sectors, are asked to implement a new recommendation, there is an important operational and philosophical distinction between recommendations such as (i) we expect "safe" wells to remain safe, but it would be wise to monitor them, and (ii) you should monitor safe wells regularly because there is a serious risk that their arsenic concentrations might increase.

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